

AN INVESTIGATION INTO THE EFFECTIVENESS OF FITTING POWERED UPPER LIMB PROSTHESES: "THE UNB EXPERIENCE"

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INTRODUCTION

In the fall of 1981, the Institute of Biomedical Engineering (IBME) at the University of New Brunswick (UNB) opened a myoelectric fitting centre, which was then called the Prosthetics Research Centre. This centre is located off the university campus and is housed in the lower level of the Stan Cassidy Centre for Rehabilitation. The rationale behind this move was to provide a clinical evaluation capability for myoelectric control systems developed at UNB.

The first client of the clinic had a below-elbow (BE) amputation and was fitted in January, 1982, with a UNB one-muscle/3-state control system [1]. Since then, over 127 clients have passed through this centre, the majority having a congenital amputation. Although the focus has shifted more towards clinical service rather than research, evaluation of new types of control systems and prosthetic components is still an on-going activity [2].

With the ever increasing costs of providing health care services in Canada, there is considerable interest in outcome measures as a means of justifying this expense. As the current cost of a powered upper limb prosthesis can run into tens of thousands of dollars, it is appropriate to try to ascertain whether this financial burden on the health care system is warranted. This is a classic problem of outcome measurement - how do you quantify 'success'? It was decided that a very simple approach was to be taken. It was deemed that if a client previously fitted with a myoelectrically controlled prosthesis is a present day user, then we can consider this a successful fitting.

Consequently, the overall goal of this retrospective study was to address two simple questions:

* What percentage of clients, fitted at UNB since the inception of the clinic, are still wearing and using a powered upper extremity prosthesis?

* If a previous client is presently not wearing a powered prosthesis, then what are the reasons?

In addition, for those clients who are still using a powered prosthesis, an attempt would be made to gather information regarding basic wearing patterns.

To answer these questions a retrospective study was initiated in the fall of 1995. The time scope of the study was from 1981 to 1995, a period of fourteen years - "The UNB Experience".

METHODOLOGY

The easiest method of examining the client base of the centre was to look at the clinic records of the individuals. From this the total number of fittings can be derived. In addition such pertinent information as date of last visit, level of amputation, age of first fitting, etc. can be determined. For more detailed information, a direct interview technique was adopted on a client-by-client basis. From these records, the clients were divided into two groups, namely the ACTIVE group and the INACTIVE group. The latter being defined as any client who had not been seen at the clinic for 36 months.

The study was conducted in three stages, and involved interviewing clients as they visited the centre, a mailed questionnaire and a telephone follow-up if necessary:

- a) As clients return to the centre (active group) for refitting, repair or re-evaluation, a questionnaire was given verbally by either the clinic manager or therapist.
- b) The inactive group were contacted by mail and asked to complete the same written questionnaire as used in (a). Naturally, this was a voluntary request which included the appropriate informed consent form.
- c) After a period of 1 month, if the questionnaire and consent form had not been returned to UNB, an attempt was made to contact the client by telephone. Responses to the questionnaire would then be elicited by telephone interview.

The Applied Statistics Centre at UNB was consulted to aid in the design of the questionnaire. This ensured that the wording of the questions were both unambiguous and in a language which was easily understood. The final questionnaire itself was very simple, comprising of only two pages, with the request that only one page was to be completed depending on whether the individual was a current wearer or not.

The 'non-wearer' questionnaire asked only two questions, namely:

- 1) When did you stop wearing your prosthesis ?
- 2) What are your reasons for not wearing a prosthesis ?

The 'wearer' questionnaire was a little more detailed and asked five questions, in order to gain additional information regarding wearing patterns:

- 1) What type of prosthesis are you wearing ?
- 2) When do you wear your prosthesis ?
- 3) Approximately how many hours each weekday/weekends do you wear your prosthesis ?
- 4) What are the reasons you chose to wear your prosthesis ?
- 5) What clinic centre is presently serving your prosthetic needs and why ?

In general the completion of the questionnaire could be achieved in less than 15 minutes. However, the time taken to cycle through the active client base was the limiting factor in how quickly this survey could be completed. Although initiated in October of 1995, compilation of the data took until February 1997.

RESULTS

Of the clients seen at UNB over the last 14 years, approximately two-thirds were below the age of 18 when first fitted. Consequently, this has resulted in over 650 prostheses being manufactured due to clients outgrowing their prostheses. As our primary thrust is in powered upper limb prosthetics, most of these prostheses (~87%) have been myoelectrically controlled. These figures make UNB the second largest powered upper limb prosthetics centre in Canada.

From the active case load, i.e. those clients who have visited the centre in the last 36 months, 90% are still using their prosthesis. For the inactive group who were contacted, only 35% reported that they continued to wear their prosthesis. This highlights the need to keep in touch with clients once a fitting has been carried out.

In the 'wearers' group, 48% used a powered prosthesis exclusively, while 14% stated that they used a non-powered device exclusively. Of the clients who reported using non-powered prostheses, it should be noted that these included a number of infants who have not yet reached the age to be fitted with a powered prosthesis. A large percentage of wearers, 38%, reported using more than one type of prosthesis. This tends to reflect the common usage of sports limbs designed for specific activities and cosmetic prostheses for social occasions. This breakdown of prosthesis type is shown in Figure 1:

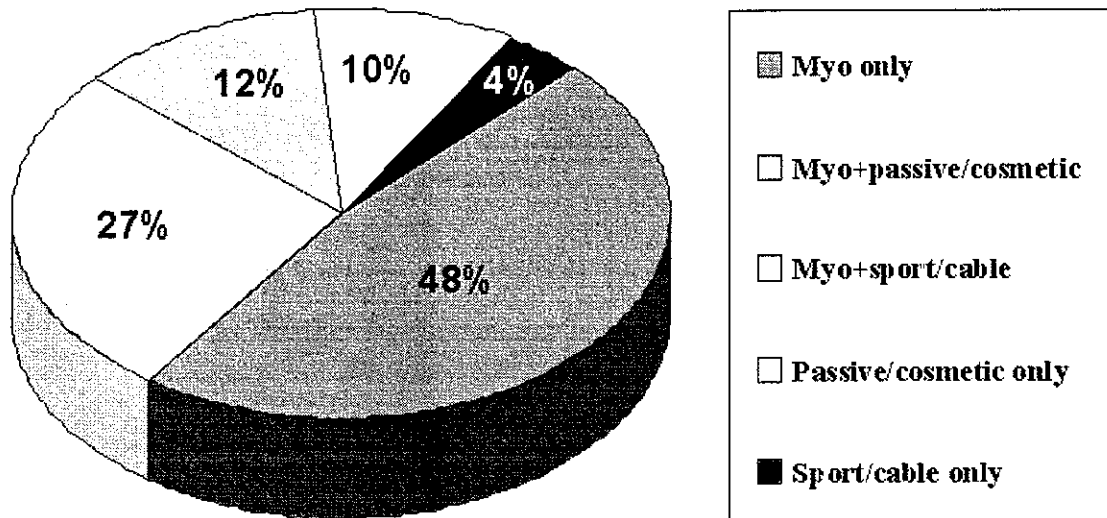


Figure 1: Breakdown of prostheses by type

The responses relating to patterns of prosthesis use were split into 'where?' and 'how long?'. It was found that most users, i.e. 83-87%, reported using their prostheses at work, school or social events, with 69% responding that they used their prosthesis only for recreation and play activities. It is interesting to note that 44% indicated that they wore their prosthesis for all activities. In addition, about a third of wearers tend to use their prosthesis less on the weekends than through the week. Again as our client pool is skewed to child amputees, this observation is probably associated with schooling activities.

The answers to the question relating how long a typical wearer used his or her prosthesis during a day were quite surprising. A substantial proportion of users, 17%, reported wearing their prosthesis all day, i.e. in excess of 12 hours, with a further 66% indicating they are using their prosthesis in excess of 4 hours per day. Consequently, around 83% of users wear their prosthesis for more than 4 hours per day. The remaining 17% tend to only use their prostheses for specific tasks which they would not otherwise be able to complete. This breakdown of usage by time is illustrated in Figure 2.

83% wear for more than 4 hours per day

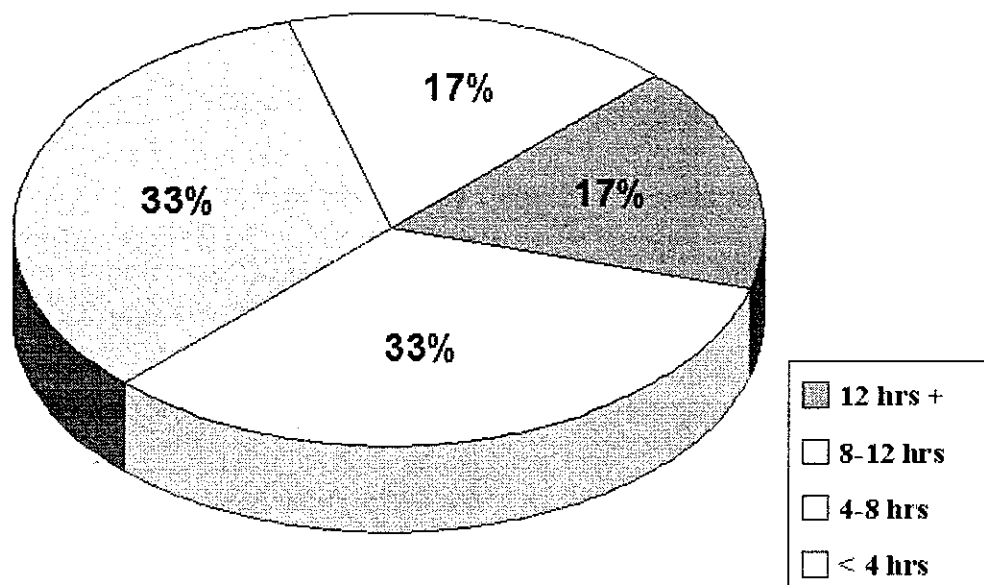


Figure 2: *Wearing patterns by time*

In the non-wearer group, 88% reported that "they got along well without it". Half of these non-wearers also indicated that the prosthetic limb was uncomfortable, while the other half responded that the prosthesis did not compare to the function of their sound limb. Three clients did not like anything at all about the prosthesis or the necessity to visit the clinic.

DISCUSSION

It is the view of the authors that the fitting of powered upper limb prosthetics at UNB is a success. This is substantiated with the finding that 76% of clients contacted are still wearing their prostheses. For these clients a powered prosthesis has become a regular part of their life. This is supported by the fact that 83% wear their prosthesis for more than 4 hours per day. However, as 38% of clients fitted use more than one type of limb, typically a sports limb and a functional powered limb, it is important for clinics to recognize that clients have varying needs and that the provision of a single prosthesis is not necessarily the total rehabilitation solution. For an amputee, a prosthetic limb is like a pair of spectacles or shoes - you may have several pair, which are worn on different occasions as the need arises.

For the clients contacted who no longer used their prosthesis (24%), it seems that for half of these people their expectations have been too great. Comparing the functionality of a powered prosthesis with the functionality of a sound limb is always going to be disappointing. Consequently, clinics have a responsibility to stress this limitation of the technology in advance of any fitting.

CONCLUSION

The fitting of myoelectric prostheses can be a success, but it requires substantial resources. The clinic at UNB has been fitting myoelectric prostheses for over 14 years, with a very low turn over of staff. Consequently, the rehabilitation team, consisting of physician, prosthetist, therapist and technician, have extensive experience in the field and are very competent. The current staff alone has over 60 person-years experience in both the fitting and repair of myoelectric prostheses. Consistent care is another reason for success. The practice of follow-up and matching the changing need of the amputee with the technology which is continually improving is an important part of the rehabilitation process. Being part of a university research institute which is at the forefront of technological advances in the field is a considerable advantage over other clinical centres. The UNB fitting centre can always call upon the expertise of mechanical and electrical engineers whenever a problem arises.

Finally, in conclusion, the "UNB Experience" in fitting myoelectrically controlled upper limb prosthetics has been a positive one, but it requires considerable experience and backup resources to make it happen.

ACKNOWLEDGMENTS

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